

# POWER 5 FOOTBALL CONFERENCES



*A quantitative  
analysis and  
redistribution of  
the NCAA  
Division I football  
athletic  
conferences*

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# Table of Contents

## INTRO

### Problem Analysis

*Pages 3-5*

- + Overview of the Power 5 Conferences
- + Problem Statement
- + Datasets and Descriptions

# 01

### Power 5 Clustering

*Pages 6-9*

- + Features and Distance Metric Selection
- + Clustering Performance
- + Expanding the Power 5
- + Location-Oriented Algorithm

# 02

### Redesigning the Power 5

*Pages 10-14*

- + Flaws of the Power 5
- + Performance-Based Conferences
- + The New Power 5
- + Assessment of a Performance-Based Power 5

# Introduction

# Problem Overview



Figure 1: NCAA Division I Power 5 conferences and universities<sup>2</sup>

## Understanding the Power 5

The Power 5 refers to five football conferences within the Football Bowl Subdivision (FBS) of the NCAA Division I, including the Atlantic Coast Conference (ACC), Big Ten Conference (B1G), Big 12 Conference, Pac-12 Conference, and Southeastern Conference (SEC)<sup>1</sup> (Figure 1). The logic behind the current organization of schools is unknown and struggles to stay in tune with high-performing teams. Through application of both university- and athletics-level data, a clustering algorithm was designed to group Power 5 schools into their current conference. An understanding and automation of the conference groupings, which are based on a range of interdisciplinary factors, could produce a more streamlined process for adding new schools to the Power 5 or redistributing present ones.

Once an accurate clustering process had been generated, the algorithm was used to assign FBS independent programs, four-year institutions whose programs are not included in an NCAA-affiliated conference, to a Power 5 conference. These schools (University of Massachusetts-Amherst, Brigham Young University (BYU) and the University of Notre Dame) currently play against programs within the Power 5 conferences despite the fact that they are not members.

## Redesigning the Power 5

Coming to an understanding on the factors that define the Power 5 structure also resulted in having a better grasp of its flaws. With these in mind, a new structure for the Power 5, both on a macro and micro scale, was explored. Through combination of athletic and academic data, an original set of criteria was conceived, and the current Power 5 schools were redistributed according to the new logic.

<sup>1</sup>Power Five conferences. (2020, September 12). [https://en.wikipedia.org/wiki/Power\\_Five\\_conferences](https://en.wikipedia.org/wiki/Power_Five_conferences).

<sup>2</sup>ESPN Staff. (2018, September 4). *Power 5 conference power rankings*. ESPN. [https://www.espn.com/college-football/story/\\_/id/24570980/power-5-conference-power-rankings](https://www.espn.com/college-football/story/_/id/24570980/power-5-conference-power-rankings).

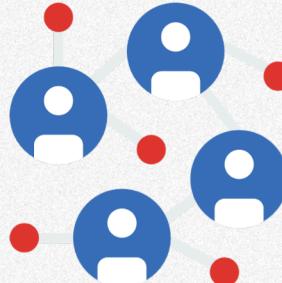
# Datasets



## Integrated Postsecondary Education Data System<sup>1</sup>

Offers a range of statistics at the university and academic level, including, but not limited to, admission rates, latitude/longitude, research funding, financial aid, and graduation rates. The database is maintained by the National Center for Education Statistics.

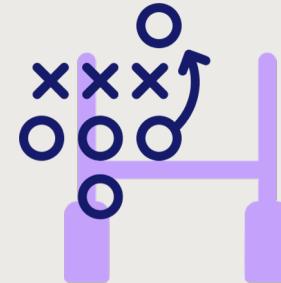
While there are a myriad of features offered in the database, only those related to admissions, financial aid, undergraduate population size, and location were considered for use in this project.



## Equity in Athletics Data Analysis<sup>2</sup>

Focuses on university athletic program statistics, including program size, revenue, classification, and operating costs. The dataset was curated by the U.S. Department of Education.

The Equity in Athletics Data Analysis (EADA) dataset offers important insights into the financial side of football programs and provides the ability to derive insights into the size of a school's media market. A program's ability to generate revenue directly correlates to their capacity to support their players and staff.



## College Football Team Stats 2019<sup>3</sup>

Provides 145 team statistics for all 130 NCAA FBS level teams, including offensive, defensive, turnover, red zone, special teams, first down, third down, and fourth down stats. The data was scraped, cleaned, and coded from the NCAA statistics website by Jeff Gallini.

While the dataset provides an in-depth look into play-by-play data for each team, only the aggregate measures of the 2019 football season were considered to control dimensionality and preserve the clustering accuracy.

<sup>1</sup>National Center for Education Statistics. (2017). Integrated Postsecondary Education Data System (2017-18) [Data file]. Retrieved from <https://nces.ed.gov/ipeds/datacenter/InstitutionByName.aspx?goToReportId=1>

<sup>2</sup>U.S. Department of Education. (2019). Equity in Athletics Data Analysis (2017-18) [Data file]. Retrieved from <https://ope.ed.gov/athletics/#/customdata/search>

<sup>3</sup>Gallini, Jeff. (2020). College Football Team Stats 2019 [Data file] Retrieved from <https://www.kaggle.com/jeffgallini/college-football-team-stats-2019>

# Power 5 Clustering

# Feature and Distance Metric Selection

## Feature Selection

The features reflected a combination of both general and athletic metrics, but primarily focus on the location and finances of each school's football program (Figure 2). As shown by both the region-based names of the Power 5 conferences and their current distributions, location proved to be a strong indicator for each conference. The features attempted to cover all management aspects of the football program, including their size, revenue, and cost of operation. These metrics provided the best picture of a school's "market" and offered further indications into the prestige of their football program.

Institution Name [0]	Longitude [2.5]	Latitude [1.5]	Revenue (\$) [1.0]	Total Undergraduates [2.0]	Participants [1.0]	Operating Expenses per Person (\$) [0.5]
Duke University	-78.9376	36.0011	37,844,852	6,536	115	23,032
...	...	...	...	...	...	...
Notre Dame	-86.2390	41.7031	107,434,072	8509	114	84,505

Figure 2: Sample of the dataset. Includes features from both the Integrated Postsecondary Education Data System and EADA dataset as well as their assigned weights.

## Distance Metric

Euclidean distance, which refers to the traditional straight-line distance between two points, was used within the k-means clustering algorithm to determine similarity between points. Use of this metric required that features be scaled to prevent domination of large values.

## Scaling and Weighting

To prevent large-valued features from dominating the decision-making, features were scaled to ensure that all criteria contributed equally. Min-Max scaling [1], also referred to as normalization, scaled the data to values between 0 and 1. While this suppressed range can reduce the impact of outliers, it ensured the algorithm's decision making was not skewed by large features.

$$X_{sc} = \frac{X - X_{min}}{X_{max} - X_{min}} \quad [1]$$

Since the features were normalized, weights were able to be applied to individual measures to increase their respective share on the clustering algorithm's decision making. To fine tune these weights, a scoring metric was devised to gauge how well a combination of weights grouped schools. The metric, which found the percentage of schools that were assigned to the correct conference, allowed weights to be optimized by an exhaustive search. Figure 2 displays each feature and its corresponding weight.

# Clustering Performance

## Algorithm Effectiveness

The k-means algorithm was able to group Power 5 conference schools into their correct conference with 79.69% accuracy (Figure 3). The algorithm likely struggled to reach a higher accuracy because football programs have repeatedly moved conferences and developed disproportionately, which made reaching 100% accuracy nearly impossible for the algorithm. It also struggled to place smaller-market schools (Vanderbilt) into their large-market conferences (SEC), but was able to capitalize on location similarities (Pac-12).

## Independent Schools

The features, distance metric, and weighting were then applied to sort three independent teams (BYU, Notre Dame, UMass-Amherst) into Power 5 conferences (Figure 3). The algorithm assigned these teams logically with respect to their features. Notre Dame, which was assigned to the ACC, already plays 4-6 football games against ACC opponents each season and are members of the ACC for all other sports.

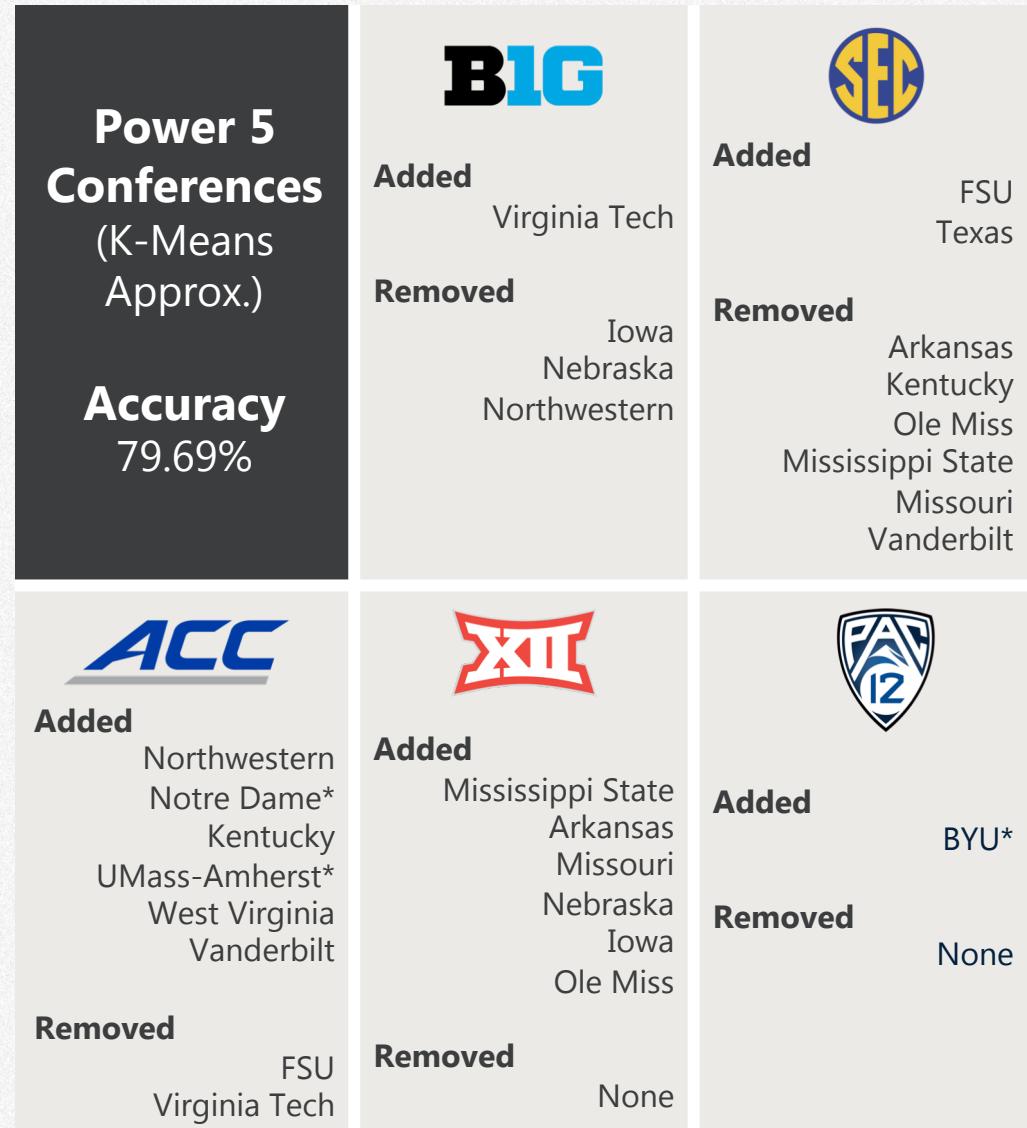


Figure 3: Chart of the approximated Power 5 conferences.  
\*Schools that were previously FBS Independent (not included in accuracy evaluation)

# Location-Oriented Algorithm

*Notre Dame, which was assigned to the ACC, already plays 4-6 football games against ACC opponents each season and are members of the ACC for almost all other sports<sup>1</sup>*

## Location-Oriented

A location-oriented algorithm ensured that location-heavy conferences, like the Pac-12, were generated with high levels of accuracy while still being able to distinguish between schools in higher-density areas, like the Eastern U.S. (Figure 4). When optimizing the feature weighting, longitude (2.5) was weighted more heavily than latitude (1.5). This difference could have resulted from the shape and distribution of Power 5 schools within the U.S., which have a wider distribution longitudinally.

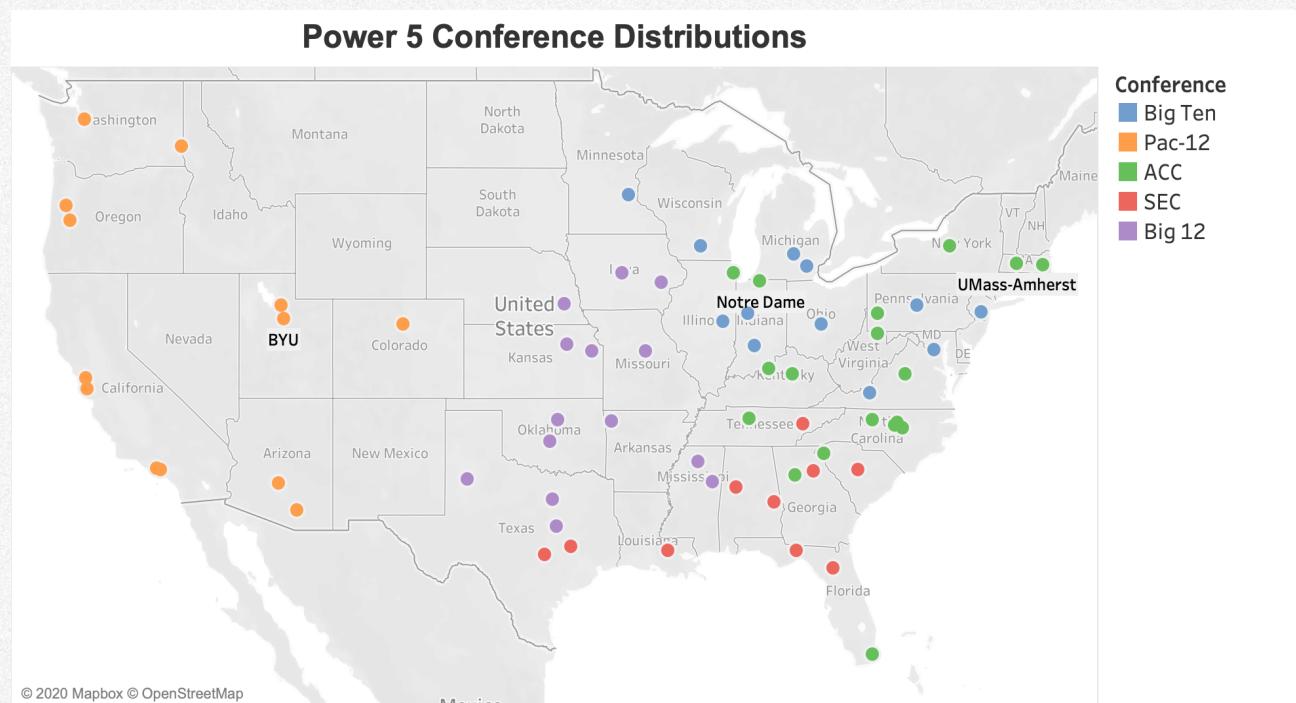


Figure 4: Map of the US showing the locations of the schools in the Power 5 conferences, including 3 FBS Independent schools (BYU, Notre Dame, UMass-Amherst), as well as the conference assigned by the k-means clustering algorithm.

<sup>1</sup>Power Five conferences. (2020, September 12). [https://en.wikipedia.org/wiki/Power\\_Five\\_conferences](https://en.wikipedia.org/wiki/Power_Five_conferences).

# Redesigning the Power 5

# Flaws of the Power 5



## Outdated Metrics

The current distribution of the Power 5 conferences is based on traditional characteristics of the program rather than the level at which the program currently plays. These metrics produce conferences that appear similar when looking at schools' locations, histories, and markets, but have large skill disparities amongst their current teams (Figure 5). While these conferences have, at some points in history, produced well-balanced divisions, the volatility of college football programs prevents this system from consistently organizing teams well.

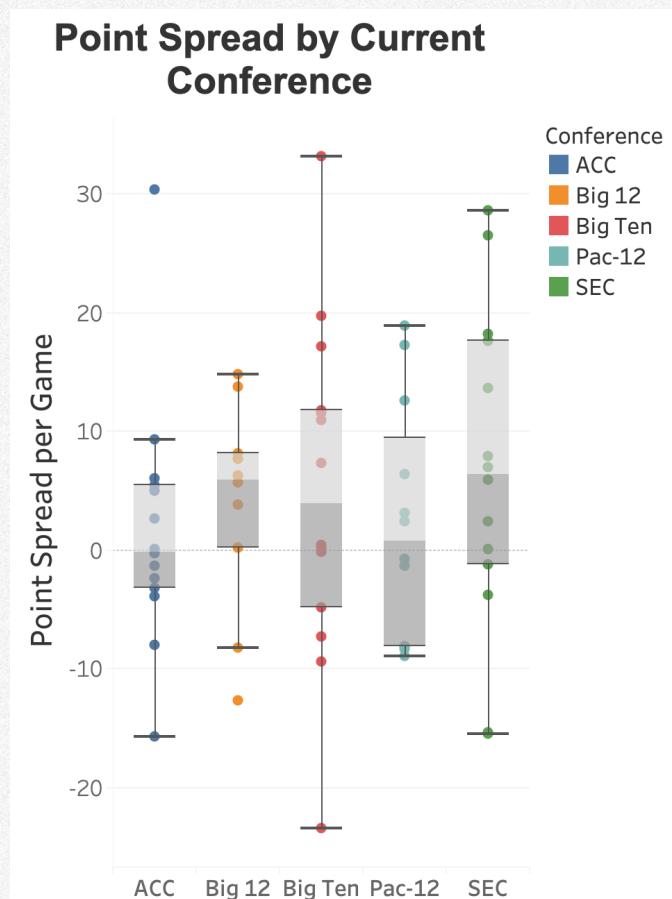


Figure 5: Box plot of the point spread per game within each Power 5 conference.



## Inert System

The Power 5's inability to shift conference distributions over time perpetrates the problems generated by its basis in tradition and prestige. By limiting the ability of teams to switch between conferences, dominant teams are able to continually capitalize on the large deviations within their conference. Not only does this provide traditionally-superior teams an easier schedule for the season, but also limits the ability of up-and-coming teams from smaller conferences to compete at a higher level.

# Performance-Based Conferences

## Feature Selection

The features reflected an intense focus on team statistics and performance from only the year previous. The forgetful system aimed to provide all teams with an equal opportunity for a competitive season and gave no consideration to the history of their team or the revenue of their program. The features, which include point spread per game (ratio of points scored to points scored by opposing team), win percentage, offensive rank, defensive rank, and yard spread per game (ratio of yards gained to yards gained by opposing team), attempted to fully capture the overall performance of a team while minimizing dimensionality (Figure 6).

## Distance Metric

Euclidean distance (see: [Feature and Distance Metric Selection](#)) was used to define the similarity between points in the application of the k-means clustering algorithm.

## Scaling and Weighting

Min-Max scaling (see: [Feature and Distance Metric Selection](#)) was similarly used to normalize the features. However, no weights were assigned to the features, as each performance metric should hold equal weight to ensure that highly-ranked teams are well-rounded across all observed metrics.

## Considerations

While the features selected attempted to group schools into conferences based on their current level of play, the performance-based system as it is proposed would require adjusted inputs to ensure an accurate and stable Power 5 in the long run. This system will have an immediate normalization effect on the metrics used to determine conferences each year, as teams will be largely playing those of equal caliber. As a result, a team's previous season conference rank and schedule difficulty will need to be fed back into the algorithm to more accurately reflect each team's performance.

Institution Name	Point Spread per Game	Win Percentage	Offensive Rank	Defensive Rank	Yard Spread per Game
Duke University	-3.9	0.417	114	56	-49.9
...	...	...	...	...	...
University of Florida	17.7	0.846	45	9	125.7

Figure 6: Sample of the dataset, generated from College Football Team Stats 2019.

# The New Power 5

## Power 5 Conferences

NCAA Football  
Season 2020-21



### Gold

Iowa St.	Ole Miss
Louisville	USC
Nebraska	Texas
UNC	Wake Forest
Oklahoma St.	Washington St.



### Diamond

Alabama	Ohio State
Clemson	Oklahoma
Florida	Oregon
Georgia	Penn St.
LSU	Utah
Minnesota	Wisconsin



### Platinum

Arizona St.	Missouri
Auburn	Pittsburgh
Baylor	TCU
Indiana	Tennessee
Iowa	Texas A&M
Kansas St.	Virginia
Kentucky	Virginia Tech
Michigan	Washington
Michigan St.	Miami



### Silver

Arizona	Oregon St.
Boston College	Purdue
Colorado	Syracuse
Florida St.	Texas Tech
Mississippi St.	UCLA



### Bronze

Arkansas	NC State
California	Northwestern
Duke	Rutgers
Georgia Tech	South Carolina
Illinois	Stanford
Kansas	Vanderbilt
Maryland	West Virginia

Figure 7: Power 5 conferences as decided by performance-based features. Ranking (highest to lowest): Diamond, Platinum, Gold, Silver, Bronze.

# Assessment of a Performance-Based Power 5

## Conference Equality

A focus on statistics and performance from the previous season generated a more equitable distribution of teams. The redistribution decreased the average range in conference point spread per game from 40.38 to 15.88 and generated similar performance shifts over multiple metrics (Figure 8). Not only would this system create more competitive matchups, but it would allow for all teams of similar caliber, despite the history of their program, to compete at the highest level in NCAA Division I.

## Talent Emergence

The redistribution could have an additional impact of highlighting talent from mid- and lower-tier Power 5 schools. These programs, who are traditionally dominated by the elite schools in their conferences, would now have the opportunity to showcase their athletes and coaching staff against teams of similar caliber.

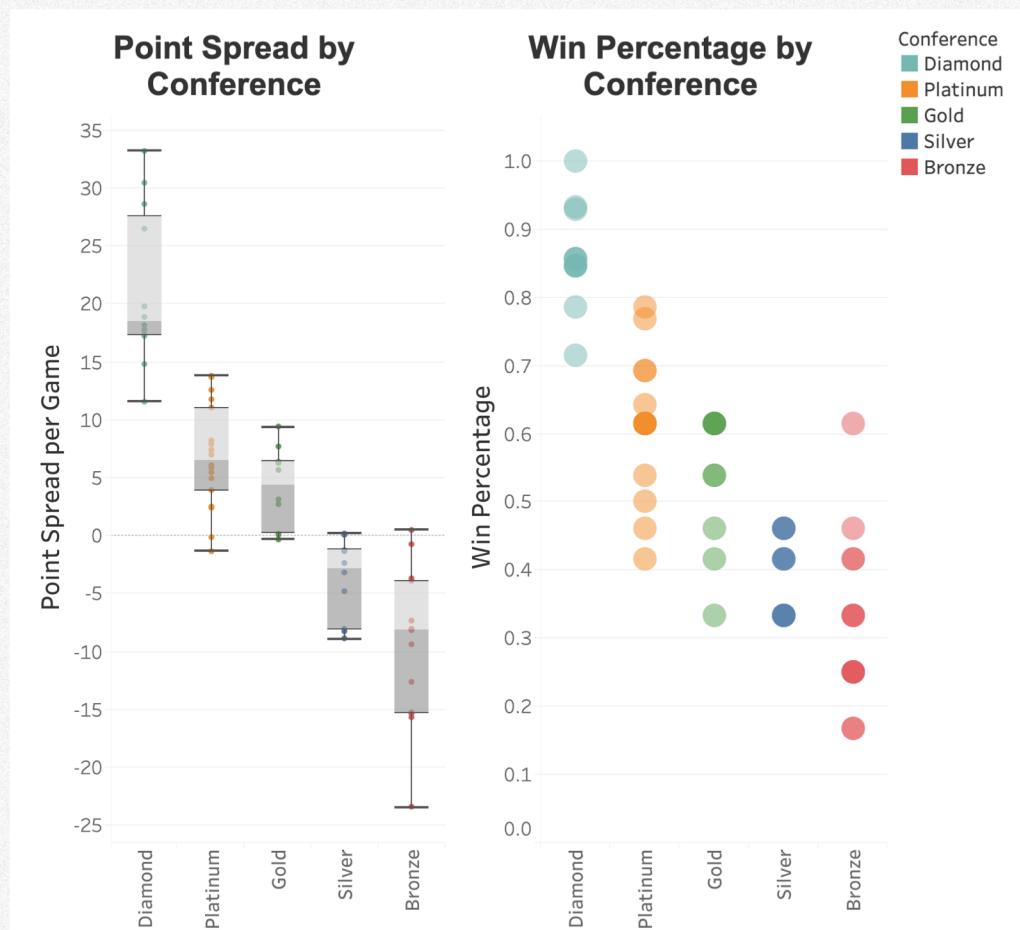


Figure 8: Box plot of the point spread per game (left) and win percentage (right) within each conference in the new Power 5

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